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IS 810 (1991): Internal Combustion Engines - Engine Valves
[TED 2: Automotive Primemovers]

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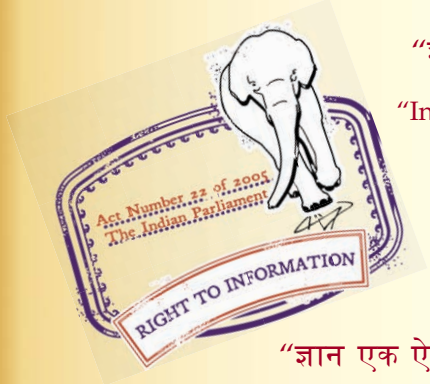

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Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS 810 : 1991
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अंतर्दाही इंजन — इंजन वाल्व — विशिष्टि

(दूसरा पुनरीक्षण)

Indian Standard

INTERNAL COMBUSTION ENGINES — ENGINE VALVES — SPECIFICATION

(Second Revision)

UDC 621·646·2 : 621·43 : 629·7

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

October 1991

Price Group 5

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Automotive Primemovers Sectional Committee had been approved by the Transport Engineering Division Council.

This Indian Standard was first published in 1974. In this revision, the scope has been enlarged to cover all types of engine valves (other than aircraft engines) presently being used by the manufacturers and the users in internal combustion engines. The types of valves included are:

Bimetallic valves, hard faced and surface treated valves.

In the preparation of this revision assistance has been derived from JIS E 101 'Engine valves for automobiles' issued by the Japanese Industrial Standards Committee.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated expressing the results of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

INTERNAL COMBUSTION ENGINES — ENGINE VALVES — SPECIFICATION

(Second Revision)

1 SCOPE

1.1 This standard specifies the general requirements for inlet and exhaust valves for all internal combustion engines other than for aircraft use.

1.2 Sodium filled valves, phosphated valves, shrouded valves and valves with more than 100 mm head diameter are not covered by this standard.

1.3 The methods of test for quality characteristics of engine valves are covered in IS 12969 : 1990.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard.

IS No.	*Title*
1586 : 1968	Methods for Rockwell hardness test (B and C scales) for steel (*first revision*)
1608 : 1972	Method for tensile testing of steel products (*first revision*)
3073 : 1967	Assessment of surface roughness
3658 : 1981	Code of practice for liquid penetrant flaw detection (*first revision*)
3703 : 1981	Code of practice for magnetic particle flaw detection (*first revision*)
7494 : 1981	Steel for valves for internal combustion engines (*first revision*)
12969 : 1990	Method of test for quality characteristics of valves

3 TERMINOLOGY

For the purpose of this standard the following definitions shall apply to denote the parts of a valve (*see* Fig. 1). The term, valve face, is to be preferred to designate the cone shaped seating surface of the valve and the term 'valve seat' is to be preferred to designate the corresponding mating part when the valve is assembled in the engine.

3.1 Crown

The extreme upper surface of the valve head.

3.2 Valve Face

Coned surface of the valve that sits on the corresponding seat surface of the cylinder head or cylinder block, as the case may be.

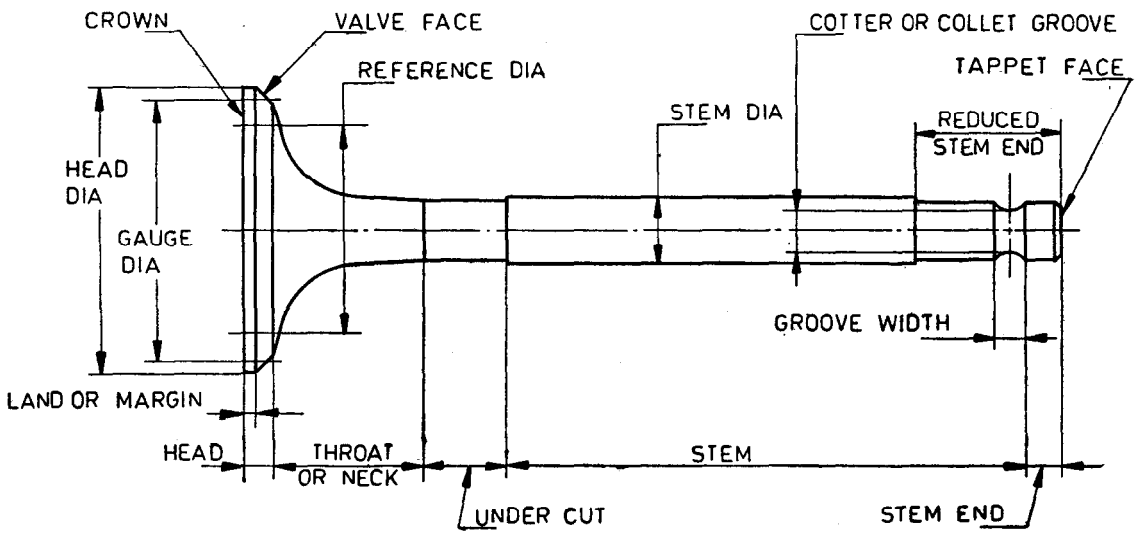


FIG. 1 TERMINOLOGY

3.3 Head

That part of the valve from the crown through the valve face.

3.4 Throat or Neck

That part of the valve connecting the valve head to valve stem.

3.5 Stem

The cylindrical part of the valve including the valve guide sliding portion.

3.6 Stem Underout

In addition to the thread or neck, a reduced portion as shown in the Fig. 1 may be used to connect the valve head to the stem. This reduction in size is with reference to the stem diameter.

3.7 Cotter (Collet) Groove or Grooves

That part of the valve meant for the insertion of cotter (collet).

3.8 Stem End

That portion of the valve stem between the groove and tappet face.

3.9 Reduced Stem End

That portion of the stem near the tappet face which is reduced below the stem diameter.

3.10 Tappet Face

The extreme end of the stem that comes in connect with the tappet, the rocker arm or the valve cap as the case may be.

3.11 Land or Margin

That part of the valve between the crown and the valve face.

3.12 Gauge Diameter

An imaginary geometrical contact diameter between the valve face and seat.

3.13 Reference Diameter

A nominal value, designated to enable measurement of head thickness against a fixed reference.

4 TYPES OF VALVES

4.1 The two main types of valves are:

a) Single piece valve; and

b) Two-piece or bimetallic construction.

There can be additional features by way of surface treatment and hard facing as well as local hardening.

4.2 Classification of Engine Valves

4.2.1 The engine valves are classified as shown below according to type of construction, surface treatment of tappet seat end and stem.

Type of Construction	*Tappet End*	*Seat*	*Surface Treatment*
Single piece	Untreated hardened button welded and hardened hard faced	Untreated hard faced induction hardened	Untreated hard chrome-plated stem soft nitrided
Two piece (bi-metallic)	Untreated hardened	Untreated hard faced	Untreated hard chrome-plated stem

5 MATERIAL

5.1 Unless otherwise specified steels for valves shall conform to IS 7494 : 1981.

5.1.1 Recommended materials for valves, hard-facing alloys for valves and heat treatment particulars are given in **A-1**, **A-2** and **A-3** respectively.

5.2 Tensile Strength

The valves shall have a minimum tensile strength of 80 kgf/mm^2 when made from a martensitic steel and 70 kgf/mm^2 when made from an austenitic alloy, when tested as per IS 1608 : 1972. A bimetallic valve shall have minimum tensile strength of 70 kgf/mm^2 (*see* IS 12969 : 1990).

5.3 Heat Treatment

Valves made from martensitic steels or austenitic alloys shall be used either in the fully heat treatment condition or in the forged and stress-relieved condition subject to the minimum tensile strength specified in **5.2**. The heat treatment particulars for the alloys are given in **A-3**. Valves made out of martensitic steels when hardened and tempered shall have a general hardness of 25 to 35 HRC, when tested as per IS 1586 : 1968.

5.3.1 Any other range of hardness may be agreed upon between the purchaser and the supplier.

6 MANUFACTURE OF VALVE FORGINGS

6.1 The valve forgings shall be manufactured either by the upsetting process or by extrusion.

6.2 The grain flow shall be continuous and shall generally follow the throat contour.

7 DIMENSIONS AND TOLERANCES

7.1 Stem Diameter

The following preferred nominal stem diameters in mm for valves are recommended:

5·0, 5·5, 6·0, 6·5, 7·0, 7·5, 8·0. 8·5, 9·0, 9·5, 10, 11, 12, 13, 14.

NOTE — Valves with higher stem diameters can be in steps of 1 mm or more to meet any specific requirements.

7.2 Valves dimensions shall be as indicated in Fig. 2. The tolerances on these indicated dimensions shall be in accordance with Table 1. Table 2 indicates the permissible tolerance for stem diameter dimensions.

7.3 Surface Finish

7.3.1 The surface finish shall be measured as per IS 3073 : 1967 and the maximum value shall be as per Table 3.

7.4 Geometrical Tolerances

7.4.1 The geometrical tolerances on measurements of characteristics shall be as given in Table 4.

7.5 For purposes of guidance, tolerance for certain other areas of the valve are indicated in Fig. 4 (*see* Fig. 3).

8 LOCKING ARRANGEMENT

Figure 5 gives the general valve locking arrangements (cotter/collet groove shapes).

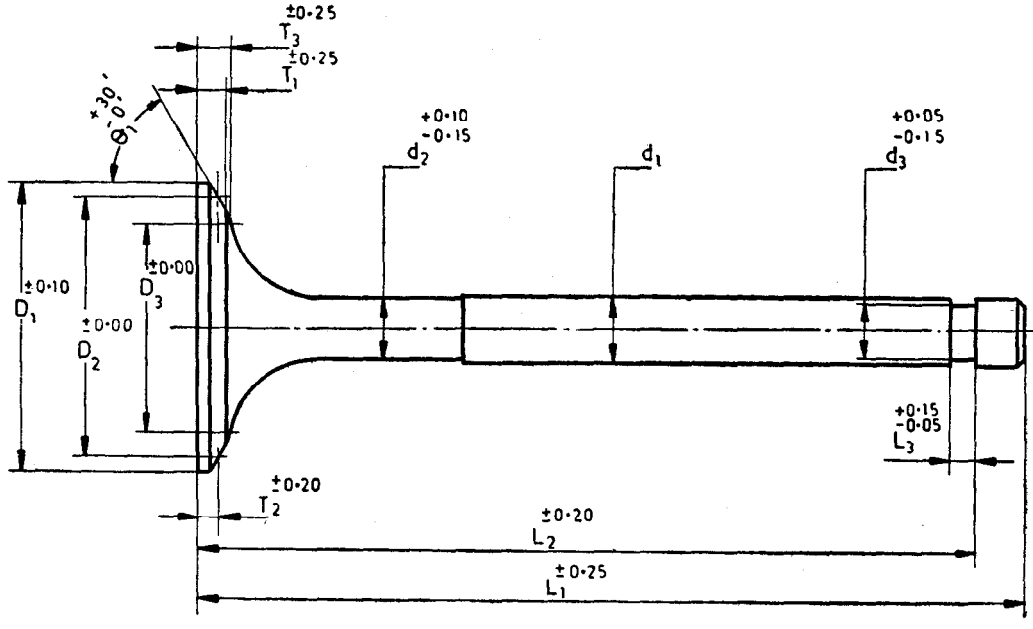
9 TAPPET FACE HARDNESS

9.1 For such of those valves that are locally hardened at the tappet end the minimum tappet face hardness shall be 48 HRC. However, for the steel X80Cr20Si2Nil, the minimum hardness applicable shall be 46 HRC. The depth of hardness shall generally be between 1 to 3 mm and the hardened zone shall not extend into the cotter/collet groove. The depth of hardness shall be assessed as the total case depth shown by macroetching.

9.1.1 However, other specific minimum hardness values, other depth patterns, such as hardening through and beyond the groove region, specifications of effective case depth in place of total case depth shall be mutually agreed to between the purchaser and the supplier.

10 HARDENED VALVE FACE

Valve shall be induction or flame hardened at the valve face as shown in Fig. 6 when so desired to increase the wear resistance. The depth of hardening shall cover completely the valve face and shall not extend more than 2 mm on the valve neck region adjoining the valve face. The recommended minimum hardness for induction hardened valve face is 45 HRC. Induction hardening of valve is applicable only to the martensitic grades of steels listed in **A-1**.



All dimensions in millimetres.

FIG. 2 DIMENSIONS — MAJOR

Table 1 Dimensional Tolerances for Valves
(*Clause* 7.2 and *Fig.* 3)

Dimension	Symbol	Tolerance mm
(1)	(2)	(3)
Head diameter	D_1	± 0·10
Gauge diameter	D_2	± 0·00
Reference diameter	D_3	± 0 00
Stem diameter	d_1	Refer Table 2
Underout diameter	d_2	+ 0 10 − 0·15
Cotter (collet) groove diameter	d_3	+ 0·05 − 0·15
Head thickness	T_1	± 0·25
Face height	T_2	± 0·20
Reference thickness	T_3	± 0·25
Overall length	L_1	± 0·25
Length from crown to groove position	L_2	± 0·20
Cotter (collet) groove width[1)]	L_3	+ 0·15 − 0·05
Valve face angle	θ_1	+ 30′ − 0′

[1)]Not applicable in the case of round and tapered grooves.

Table 2 Dimensions for Stem Diameters
(*Clause* 7.2)

Stem Diameter mm	Tolerances mm
3-6	− 0·015
> 6-10	− 0·020
>10-18	− 0·025

NOTE — Tolerance for stem diameter 18 mm and above shall be as agreed to between the purchaser and the supplier.

Table 3 Surface Finish on Ground Regions
(*Clause* 7.3.1)

	Surface Finish μ Ra, *Max*
Stem	0·5
Valve face	0·8
Tappet face	0·6

11 HARDFACING OF VALVE FACE

The hardfacing and induction hardening of valve face shall be as shown in Fig. 6. The corrosion and wear resistance of the valve face shall be increased and the service life of valves in general and exhaust valves in particular shall be extended when a suitably machined groove at the valve face is hardfaced with an alloy that is superior to the valve material as shown in Fig. 6. The deposit shall be made by oxyacetylene or by any other approved method of welding (*see* **A-2**).

12 SURFACE TREATMENT FOR VALVES

12.1 The valve shall be given one of the following two surface treatments, to improve the anti-seizure properties of the valve stem in particular and the corrosion resistance of the valve in general. The testing procedures are outlined in IS 12969 : 1990.

12.1.1 *Hard Chromium Plating*

Figure 7 shows the details of the stem region protected by hard chromium plating along with the suggested minimum plating thickness. When specified, the hard chromium plating shall be carried out in a plating bath by any one of the standard electrochemical methods. The plating thickness shall be 0·003 mm minimum. Higher plating thickness values shall be as agreed to between the purchaser and the supplier.

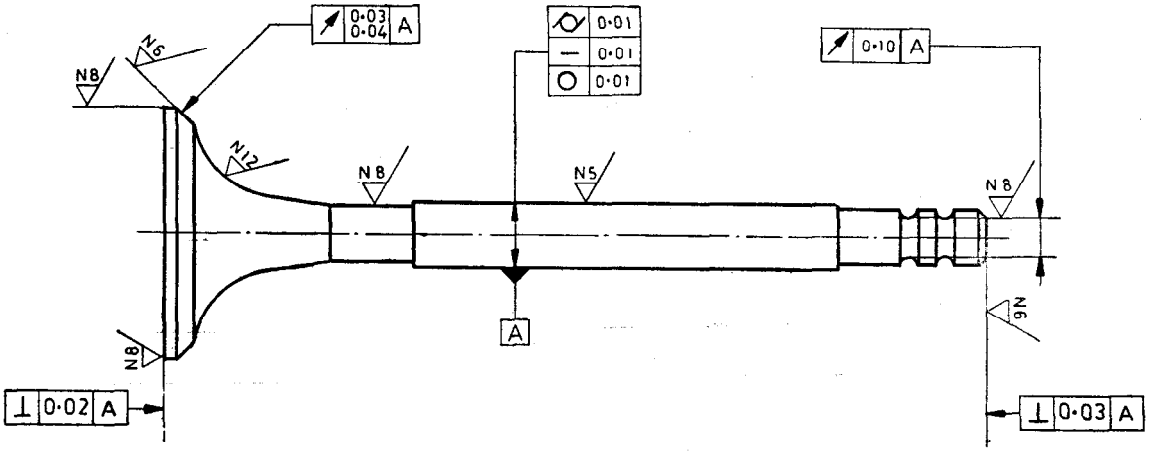


FIG. 3 GEOMETRY AND SURFACE ROUGHNESS

Table 4 Geometrical Tolerances, mm
(*Clause* 7.4.1)

Face runout	0·03 for head diameter up to 50 mm 0·04 for head diameter of 50 mm and above but below 75 mm[1)]
Stem circularity	0·01
Stem straightness	0·01
Stem cylindricity	Half the stem diameter tolerance subject to a minimum of 0·010
Groove runout	0·10
Tappet face runout	0·03
Crown face runout	0·20

[1)]The face runout for valves with head diameter 75 mm and above shall be mutually agreed to between the purchaser and the supplier.

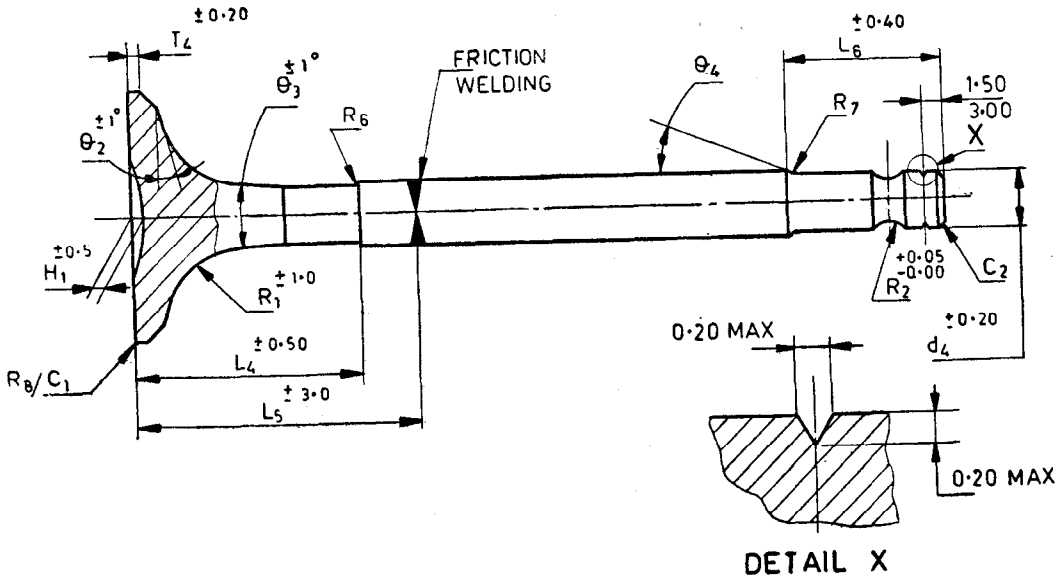
12.1.2 *Soft Nitriding*

When specified the soft nitriding shall be carried out either by gas nitriding or liquid nitriding, to a minimum total case depth of 0·010 mm and a minimum hardness of 500 HV at 200 g load.

13 BUTTON WELDED OR HARDFACED TAPPET FACE

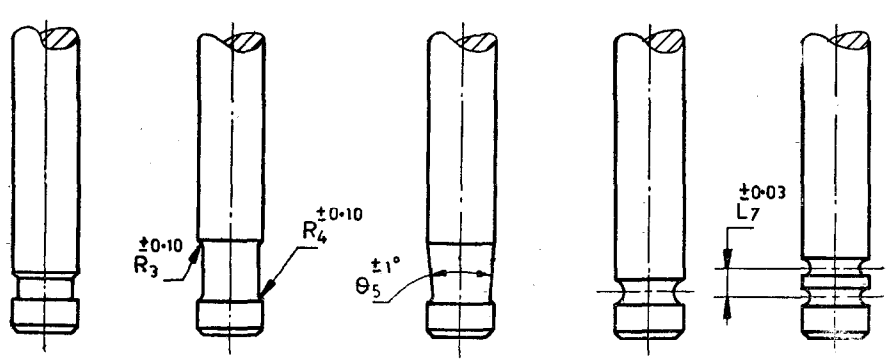
13.1 Austenitic valves in general and martensitic valves in a few cases shall be constructed in one of the following two ways to provide increased hardness and wear resistance at the tappet end.

13.1.1 The valve shall have a welded button of a hardenable wear resistant (martensitic) steel which shall have a thickness in the range of 2 to 3 mm. This region shall subsequently be hardened to a minimum tappet face hardness of 48 HRC.



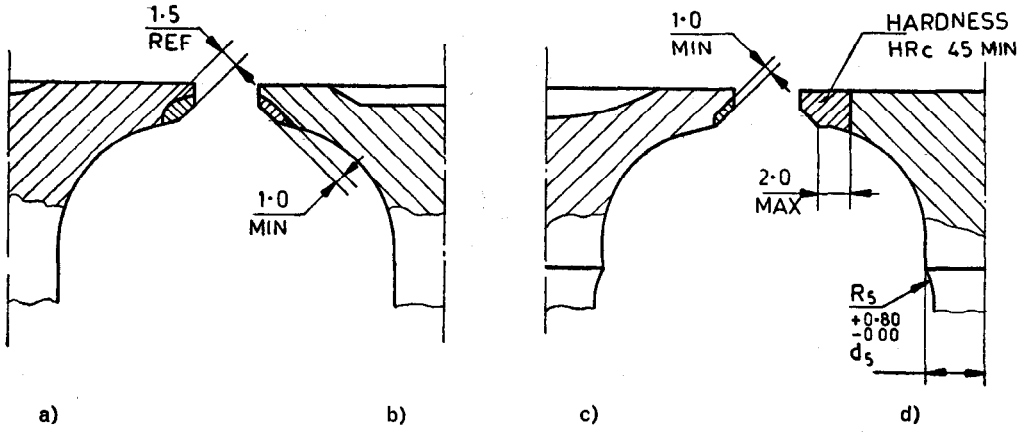
All dimensions in millimetres.

FIG. 4 DIMENSIONS : OTHER AREAS : MINOR



All dimensions in millimetres.

FIG. 5 LOCKING ARRANGEMENT (COLLET/COTTER GROOVE)



All dimensions in millimetres.

FIG. 6 HARDFACING AND INDUCTION HARDENING OF VALVE FACE

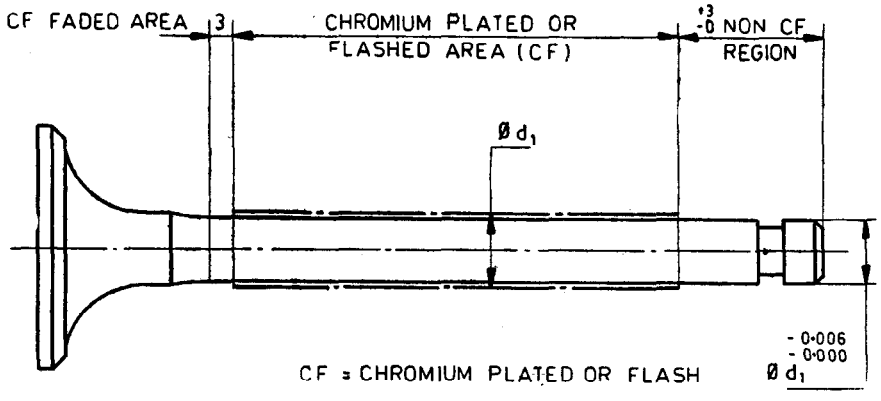


FIG. 7 CHROMIUM PLATING

13.1.2 Hardfacing of the tappet face shall consist of depositing by oxy-acetylene flame or by any other approved welding methods, approximately 1 to 2 mm layer of a wear resistant material. A few typical hardfacing alloys, along with values of minimum hardness obtainable after hardfacing, are indicated in **A-2**. Other alloys, not indicated in **A-2** shall be used subject to agreement between the purchaser and the supplier.

14 SURFACE IMPERFECTIONS

14.1 The valve shall be free of tool marks or any other cut marks that are likely to interfere with the functioning of the valve. However, certain minor blemishes due to forging, machining or handling shall be permitted subject to agreement between the purchaser and the supplier. Typical minor forging flaws are those in the crown and throat (neck) regions and shall not be deeper than 0·5 mm and the root shall not be a V-notch. Hardness check marks taken on Rockwell 'A' scale or Vickers are acceptable. Circumferential indications either in visual inspection or in crack detection are not acceptable except at the button welded interface where an external gap width and depth of 0·2 mm maximum are permitted. Longitudinal seams typical of continuously cast raw material is permitted over the stem region of the valve but shall not extend into the undercut or groove regions. The depth of these seams shall be less than 0·5 mm and the root shall not be a V-notch.

15 TESTS

15.1 Macro Etch Examination

15.1.1 Valves shall be subjected to a grain flow detection test by hot etching in hydrochloric acid, cold etching in Marble's Reagent, or by any other approved method of macro etching. The etching shall be done so as not to cause excessive pittings and corrosion of the sample. The grain flow shall be continuous and shall generally follow the throat contour.

15.2 Crack Detection Test

15.2.1 Valves when tested for crack detection by the magnetic crack detection, the colour dye penetrant, the fluoroscopic dye penetrant or by any other approved method as agreed to between the purchaser and the supplier, shall

be found free from cracks (*see* IS 3 703 : 1980 and IS 3658 : 1981).

15.3 Microstructure Test

15.3.1 Valves shall be subjected to a microstructure test by an approved method of specimen preparation and the structure so observed shall correspond to the type of steel or alloy used and the heat-treatment carried out on the valve. The three types of heat treatment conditions for valve material are:

a) Hardened and tempered structure for the martensitic steels,

b) As-rolled and annealed structure, or

c) Solution treated structure for the austenitic alloys.

16 MARKING

16.1 Each valve shall be legibly and indelibly marked, part number, batch number and source of manufacture. The markings shall be such that they do not interfere with the function of the valve.

16.2 Valves shall not be deeply stamped on the crown for identification and the method of marking shall be as agreed upon between the purchaser and the supplier.

17 PRESERVATIVE TREATMENT

Each valve shall be coated with a suitable rust preventive oil or medium which is easy to remove when required for subsequent assembly.

18 PACKING

Valves shall be packed suitably as per the best prevalent trade practice.

ANNEX A

(*Clauses* 5.1.1 *and* 10.1)

RECOMMENDATIONS FOR VALVES HARDFACING AND TEMPERATURE FOR HEAT TREATMENT

A-1 MATERIALS FOR INLET AND EXHAUST VALVES

Sl No.	Material	Type	C	Si	Mn	Ni	Cr	Mo	W	V	N_2	S *Max*	P *Max*
1.	40Cr4	M	0·35-0·45	0·10-0·35	0·60-0·90	—	0·90-1·20	—	—	—	—	0·04	0·04
2.	40Ni6Cr4Mo3	M	0·35-0·45	0·10-0·35	0·40-0·70	1·25-1·75	0·9-1·3	0·2-0·35	—	—	—	0·035	0·04
3.	X50Cr9Si2	M	0·45-0·55	1·0-2·0	0·6 *Max*	0·6 *Max*	7·5-9·5	—	—	—	—	0·035	0·04
4.	X45Cr9Si3	M	0·40-0·50	2·75-3·75	0·80 *Max*	0·50 *Max*	7·50-9·50	—	—	—	—	0·035	0·04
5.	X40Cr11Si2Mo1	M	0·35-0·45	1·8-2·5	0·6 *Max*	—	10·0-12·0	0·7-1·3	—	—	—	0·035	0·04
6.	X80Cr20Si2Ni1	M	0·75-0·85	1·75-2·50	0·80 *Max*	1·00-1·70	19·0-21·0	—	—	—	—	0·035	0·04
7.	X45Cr19Ni9Si3W1	A	0·4-0·5	2·0-3·0	0·8-1·5	8·0-10·0	17·0-20·0	—	0·8-1·2	—	—	0·035	0·05
8.	X20Cr21Ni12N	A	0·15-0·25	0·75-1·25	1·5 *Max*	10·5-12·5	20·0-22·0	—	—	—	0·15-0·30	0·035	0·05
9.	X70Cr21Mn6Ni2N	A	0·65-0·75	0·45-0·85	5·5-7·0	1·4-1·9	20·0-22·0	—	—	—	0·18-0·28	0·035	0·05
10.	X55Cr21Mn8Ni2N	A	0·50-0·60	1·0 *Max*	7·0-9·5	1·5-2·75	20·0-22·0	—	—	—	0·20-0·40	0·035	0·05
11.	X53Cr22Mn9Ni4N	A	0·48-0·58	0·25 *Max*	8·0-10·0	3·25-4·50	20·0-23·0	—	—	—	0·38-0·50	0·035	0·05
12.	X30Cr20Ni11Mo2P	A	0·25-0·35	1·0 *Max*	1·2 *Max*	10·0-12·0	19·0-21·0	1·8-2·5	—	B. 0·01-	—	0·035	0·18-0·25
13.	X33Cr23Ni8Mn3N	A	0·28-0·38	0·5-1·0	1·5-3·5	7·0-9·0	22·0-24·0	—	—	—	0·25-0·40	0·035	0·05
14.	Nickel Alloy 80A	A	0·10 *Max*	1·0 *Max*	1·0 *Max*	Base	18·0-21·0	Ti 1·0-2·70 Fe 3·0 *Max*		Al 1·0-1·80 Co 2·0 *Max*		0·03	0·045
15.	Nickel Alloy 751	A	0·10 *Max*	1·0 *Max*	1·0 *Max*	70·0 *Min*	14·0-17·0	Ti 2·0-2·6 Al 0·9-1·5		Fe 5·0-9·0 Nb+Fa 0·7/1·2		0·03	0·045

NOTES

1 Alloys 9, 10 and 11 may have sulphur upto 0·09 percent for free machining.

2 The letter 'M' has been used to denote Martensitic steels and the letter 'A' to denote Austenitic steels/alloys.

A-2 MATERIALS FOR VALVE HARDFACING

(*Clauses* 11 *and* 13.1.2)

Alloy	C	Si	Mn	Ni	Cr	Co	W	Fe	Deposit Hardness HRC	Typical Application
CoCr Alloy Type 1	2·0-3·0	0·4-2·0	1·0 *Max*	3·0 *Max*	26·0-33·0	Base	11·0-14·0	3·0 *Max*	48 *Min*	Tappet end
CoCr Alloy Type 12	1·0-1·7	0·4-2·0	1·0 *Max*	3·0 *Max*	26·0-33·0	Base	7·0-9·5	3·0 *Max*	45 *Min*	Tappet end and valve face
CoCr Alloy Type 6	0·9-1·4	0·4-2·0	1·0 *Max*	3·0 *Max*	26·0-33·0	Base	3·0-6·0	3·0 *Max*	38 *Min*	Valve face
CoNiCr Alloy Type 32	1·5-2·0	0·9-1·3	0·3 *Max*	21·0-23·0	24·0-27·0	Base	11·5-13·0	0·85-1·35	38 *Min*	Valve face
Nickel Alloy 60	0·3-0·7	2·5-5·0	3·0 *Max*	58·0-63·0	14·0-18·0	—	—	Balance	20 *Min*	Valve face
FeCrNiMo Alloy	2·0-2·5	0·8-1·3	—	10·0-12·0	22·0-26·0	—	Mo 5·0-6·0	Base	35 *Min*	Valve face
Fe Cr Alloy	2·5-2·7	—	—	—	25·5-28·5	—	—	Base	50 *Min*	Tappet face

NOTE — The hardness figures given refer to the as cast hardness and the hardfacing alloys are not heat-treatable.

A-3 HEAT TREATMENT TEMPERATURES FOR VALVE MATERIALS

(*Clause* 5.3)

Sl No.	Material	Temperature, °C			
		Harden	Temper/SR	Solution Treat	AGE/SR*
1.	40Cr4	860-890	550-700	—	—
2.	40Ni6Cr4Mo3	820-850	500-660	—	—
3.	X50Cr9Si2	1 000-1 050	650-750	—	—
4.	X45Cr9Si3	1 020-1 070	720-820	—	—
5.	X40Cr11Si2Mo1	980-1 080	700-800	—	—
6.	X80Cr20Si2Ni1	1 050-1 080	700-800	—	—
7.	X45Cr19Ni9Si3W1	—	—	980-1 080	—
8.	X20Cr21Ni12N	—	—	1 100-1 200	700-800*
9.	X70Cr21Mn6Ni2N	—	—	1 100-1 200	730-780
10.	X55Cr21Mn8Ni2N	—	—	1 100-1 200	730-780
11.	X53Cr22Mn9Ni4N	—	—	1 100-1 200	730-800
12.	X30Cr20Ni11Mo2P	—	—	1 120-1 150	730-760
13.	X33Cr23Ni8Mn3N	—	—	1 100-1 180	760-790
14.	Nickel Alloy 80 A	—	—	1 020-1 100	700-750
15.	Nickel Alloy 751	—	—	1 020-1 100	700-800

*NOTE — Ageing is optional.

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufactures or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

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Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference:

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